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Observing System

National Aeronautics and Space Administration

EARTH SYSTEM OBSERVATORY

The Benefit of NASA's Atmosphere Observing System (AOS) Mission Lidar and Polarimeter Observations for Health and Air Quality Applications

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AOS Architecture

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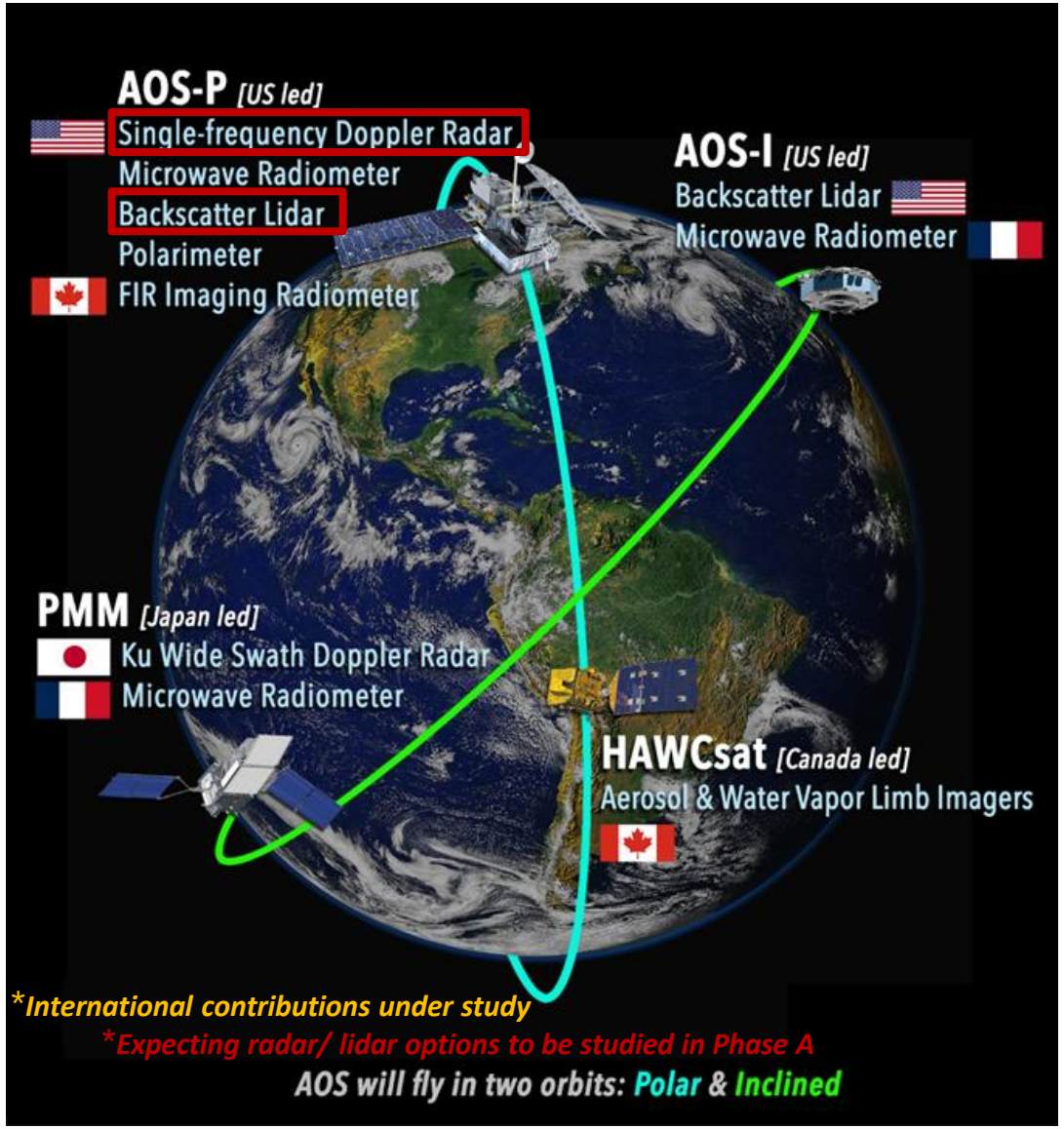

- Two orbits
- AOS-P
  - Polar orbit
  - Sun synchronous, passes over a given location at the same time every day
  - Global coverage
- AOS-I
  - Inclined Orbit
  - Observes diurnal variability
  - 55°S - 55°N
  - Earlier launch

*** AOS architecture not final**

AOS Instruments for AQ

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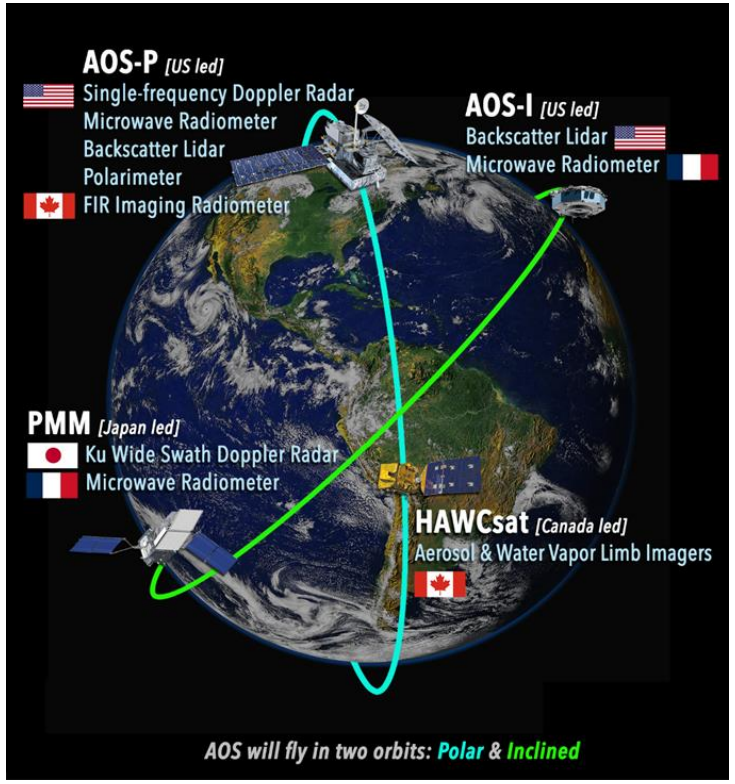
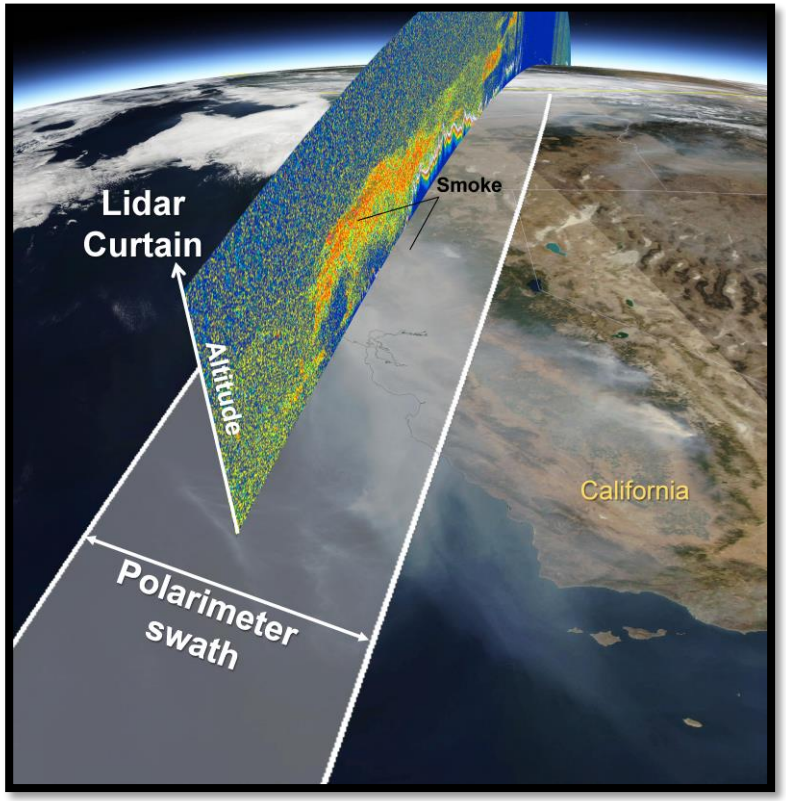


*** AOS architecture not final**

AOS-I1	
Backscatter Lidar	532nm, 1064nm
AOS-P1	
Backscatter Lidar	532nm, 1064nm
Polarimeter	UV/VIS, VNIR/SWIR Narrow Swath



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AOS Applications

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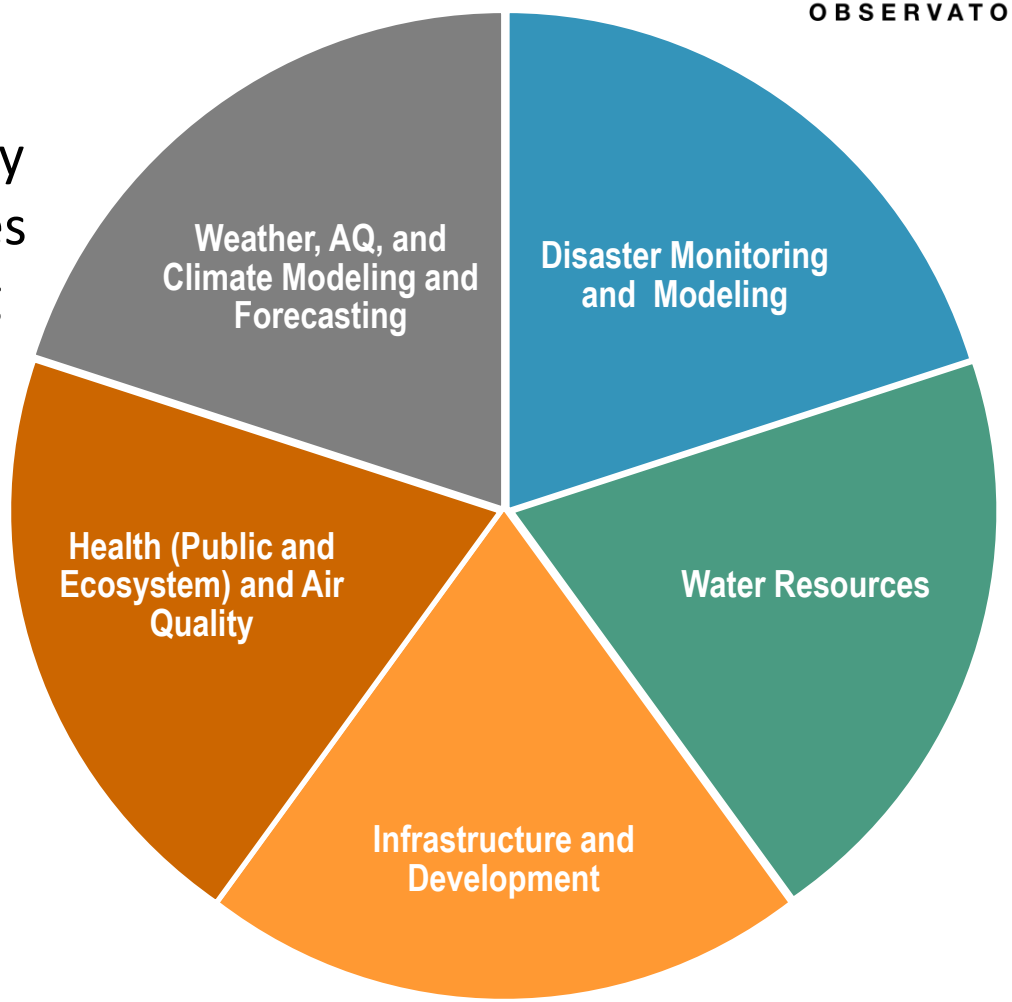
AOS will provide key information to support decision making at timescales from hours to decades, enabling improved weather and air quality forecasting today, seasonal to sub-seasonal changes in the near future, and societal challenges resulting from climate change in the decades to come.



The AOS Applications Team (AIT) is charged with **ensuring that applications are considered to the greatest extent possible** in mission design and implementation**.**

Phase-A activities focus on **updating the Applications Traceability Matrix, development of a Project Applications Plan and recruitment of the earliest Early Adopters**

Program of Record: Applications

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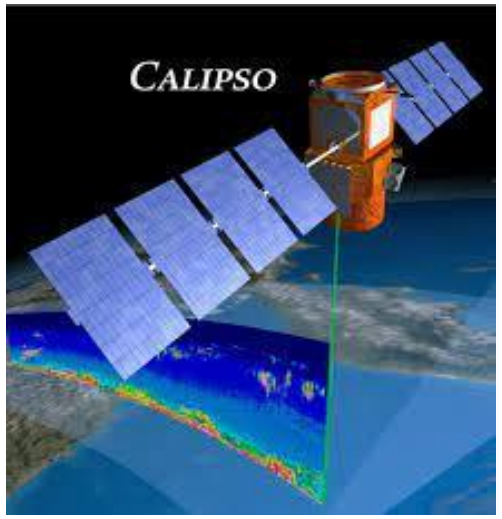
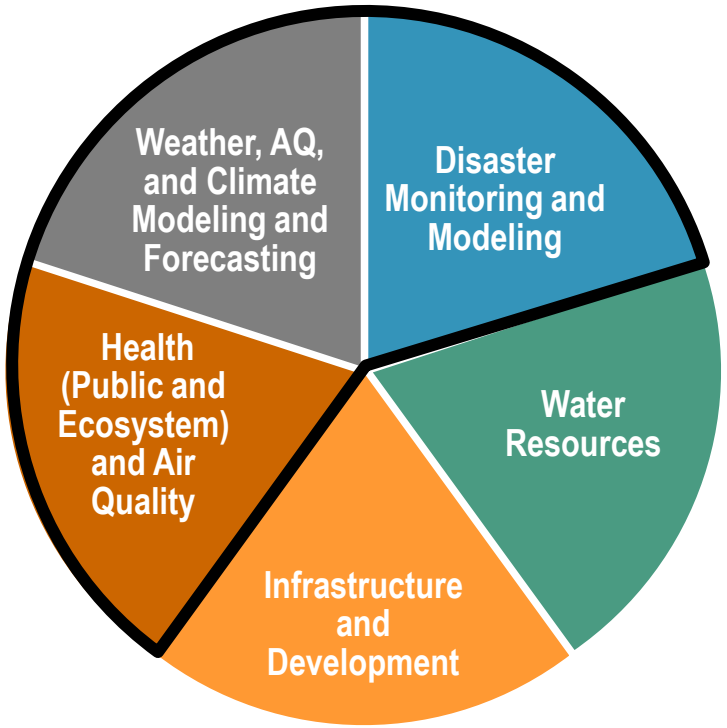
CALIPSO



- Air Quality Forecasting
- Air Quality Modeling
- Air Quality Assessments
- Hazardous Plume Forecasting
  - Volcanic Ash
  - Smoke
  - Dust

AOS



MODIS/VIIRS

- Air Quality Forecasting
- Air Quality Modeling
- Air Quality Assessments
- Public Health

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Operational Data Assimilation and AQ Forecasting

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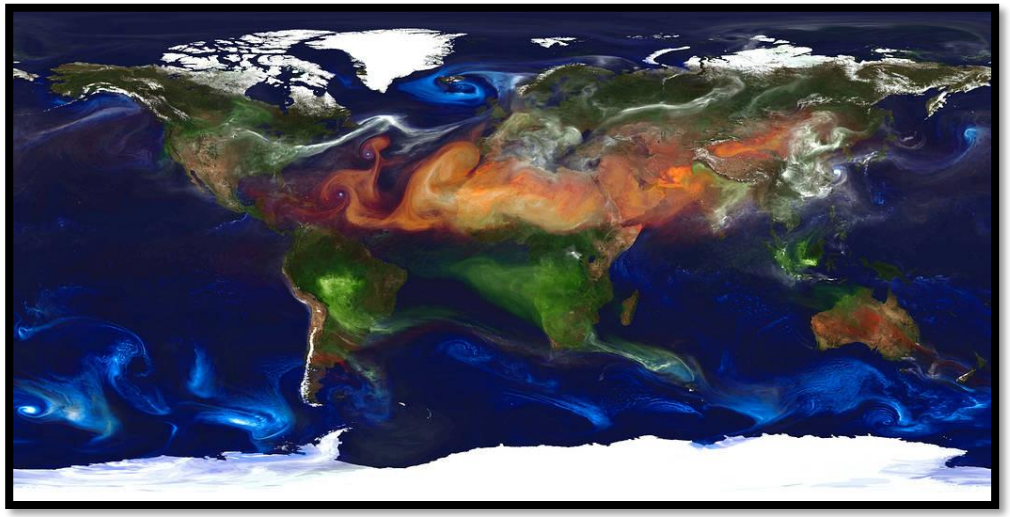
What can we learn about this community of users?

- Assimilation of AOD has heritage at several global modeling centers (e.g, NASA GEOS, NRL NGAPS, ECMWF CAMS)
  - Increases the accuracy of short-term (~1-10 day) forecasts
- Assimilation of novel observations requires considerable time and resources
- Data needs:
  - Latency < 6 hours
  - Level 1 or Level 2 products



MODIS AOD is routinely assimilated into the NASA GEOS Forward Processing (FP) weather and aerosol forecast

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Hazardous Plume Forecasting

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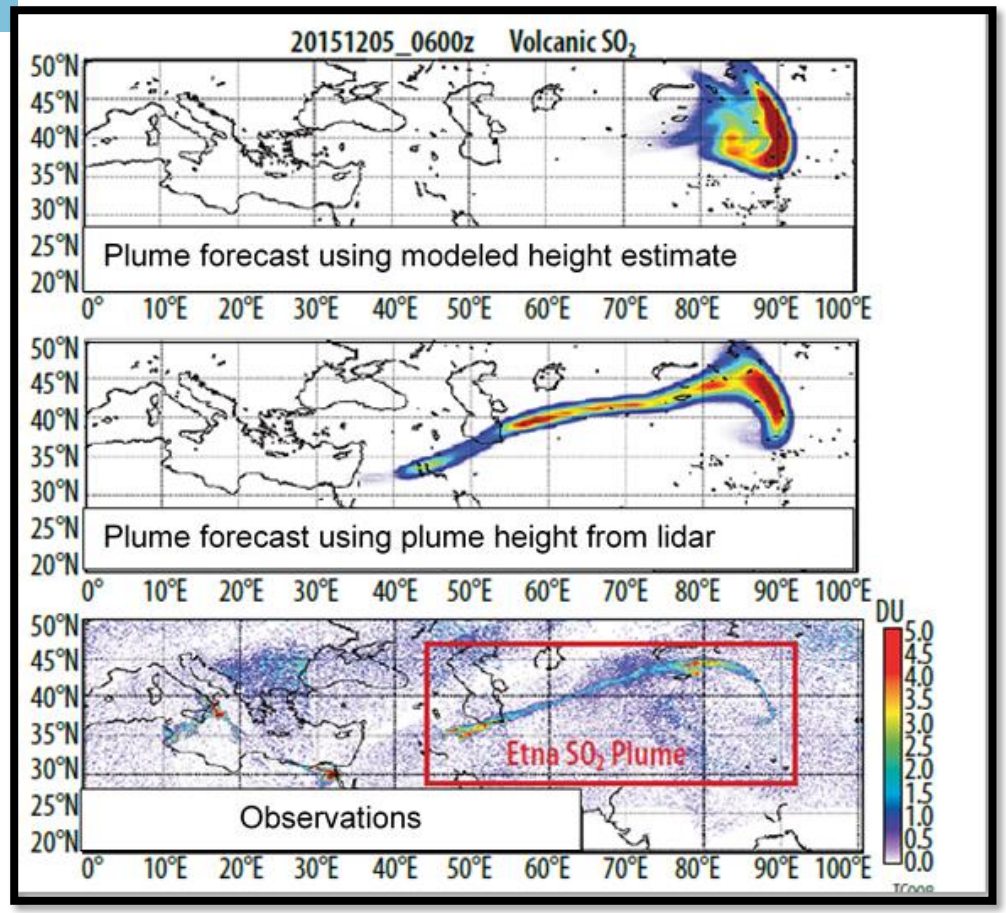
What can we learn about this community of users?

- Require quantitative information
  - Plume height, thickness, mass
  - For volcanic plumes: Discrimination between ash, dust, and SO2
- Data needs:
  - < 3h latency is most useful
- Require readily ingestible and digestible information



Low latency observations of the vertical profile of aerosols, such as from lidar, are critical to providing accurate forecasts of plume transport. Figure adapted from Hughes et al. (2016).

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Latency

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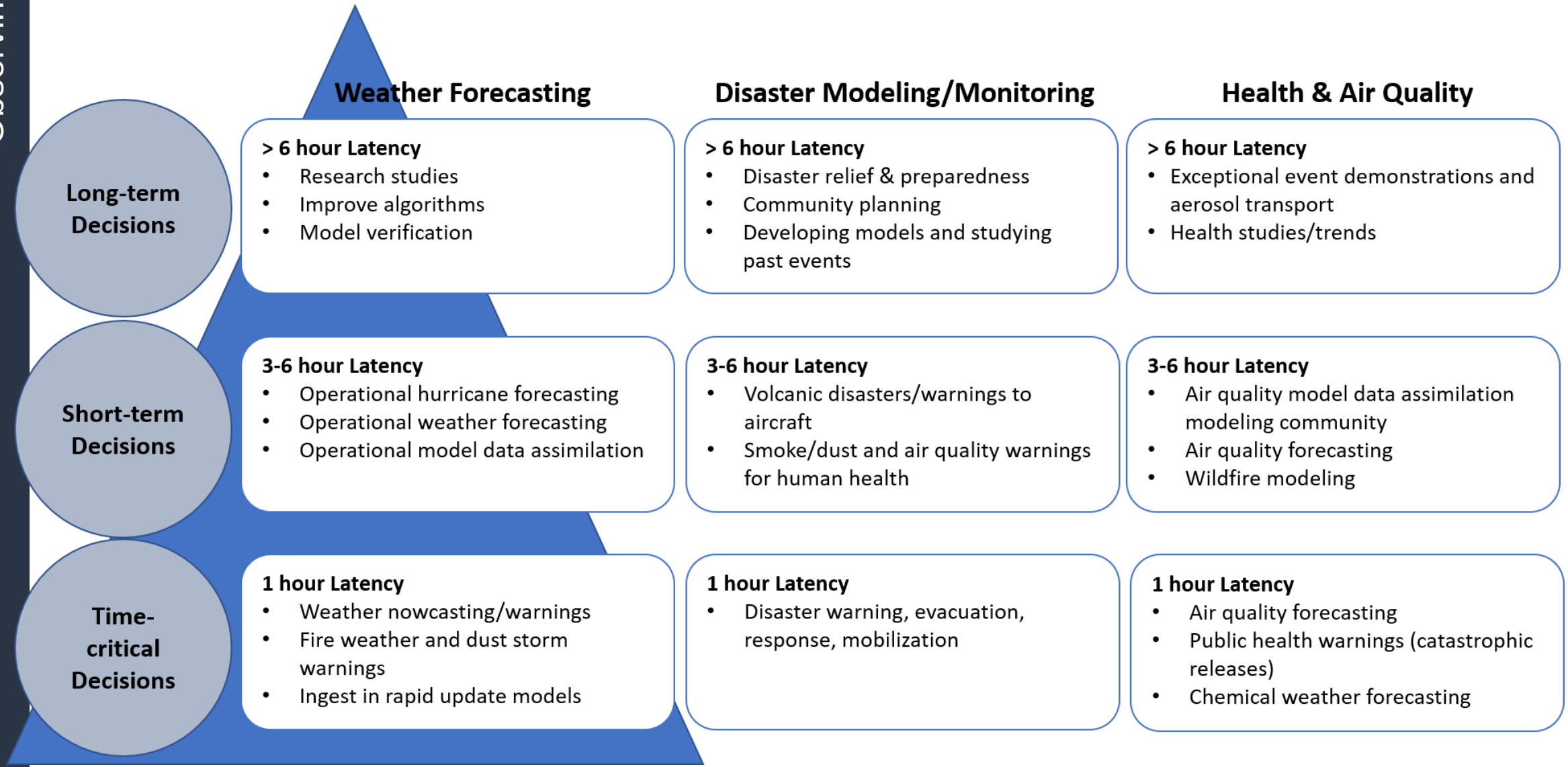

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Pre-Phase A

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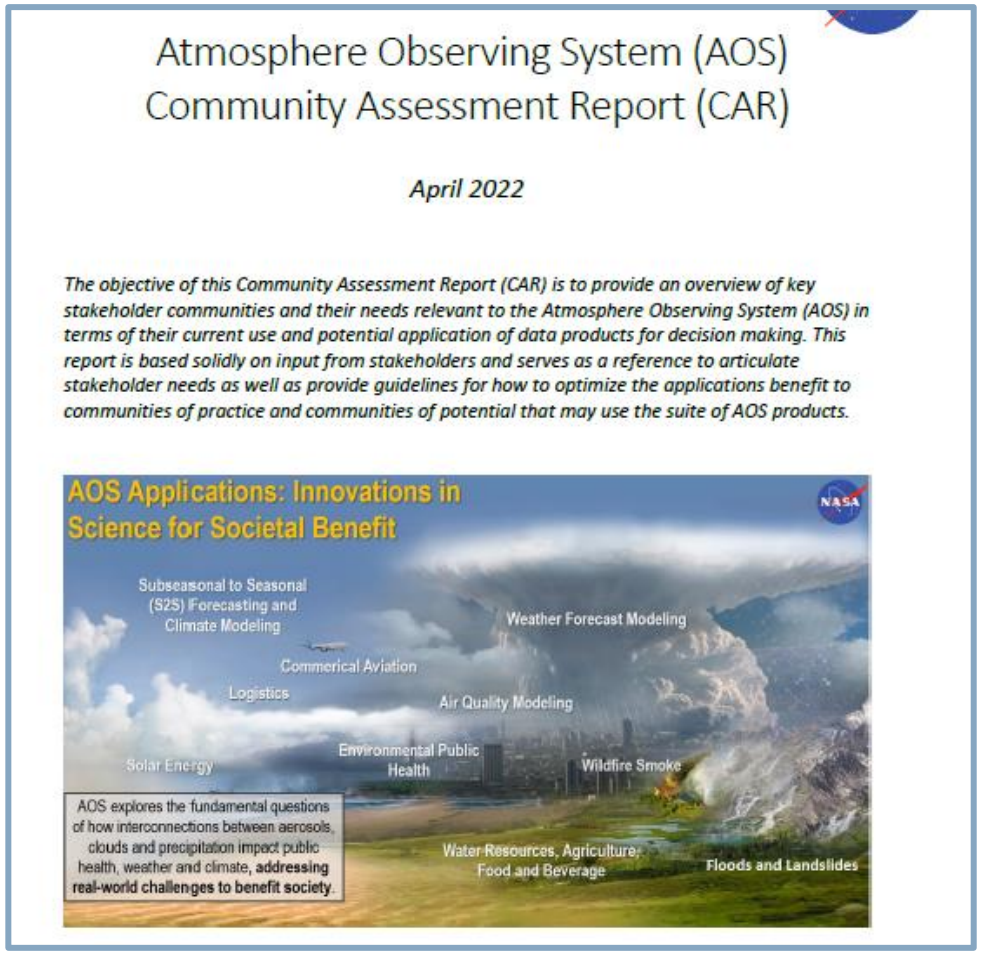
- **Pre-Phase A- Community Assessment Report (CAR)**
  - Documents and synthesize information and **needs from applications communities relevant to AOS**
  - CAR makes recommendations and provides suggested guidelines for how **components of the AOS mission may be optimized** for enhanced applications value
  - CAR is a living document that will be **maintained throughout the mission life cycle**


Atmosphere Observing System (AOS)
Community Assessment Report (CAR)

April 2022

The objective of this Community Assessment Report (CAR) is to provide an overview of key stakeholder communities and their needs relevant to the Atmosphere Observing System (AOS) in terms of their current use and potential application of data products for decision making. This report is based solidly on input from stakeholders and serves as a reference to articulate stakeholder needs as well as provide guidelines for how to optimize the applications benefit to communities of practice and communities of potential that may use the suite of AOS products.

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CAR Findings

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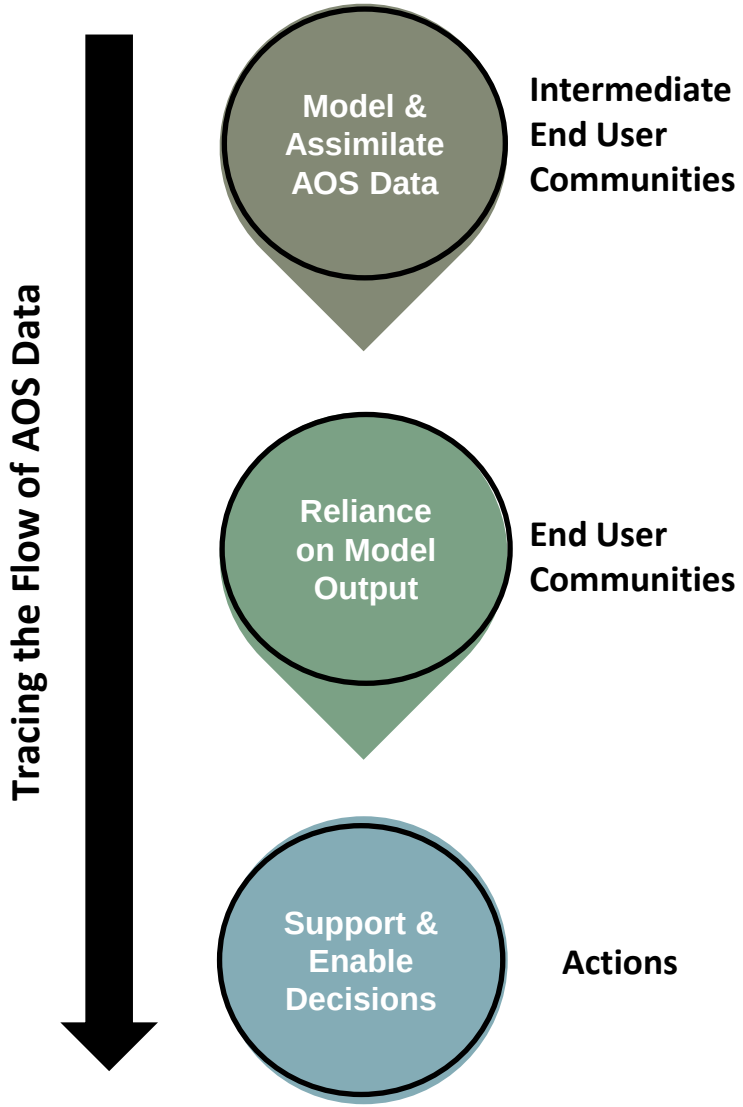
- **No "One Size Fits All" Approach:** Stakeholder needs vary significantly, even within the same community
- **Capacity and capabilities vary:** Largely dependent on organizational resources and capacity
- **Measurement Uncertainty is important:** Accuracy and knowledge of uncertainties is a major driver impacting likelihood to use data or products for decision making
- **Intermediate data product/service providers are vital:** many stakeholder communities rely on value added service providers for their information rather than going directly to the data sources
- **Reliance on models:** presents an opportunity to assimilate and/or incorporate data to improve models

Community Reliance on Model Output and Gridded Products

The AOS mission design that "raises the bar" for science also does the same for applications.

- Many communities would benefit from improved forecasts
- Providing gridded datasets for desired observables (precip + $PM_{2.5}$) is the single most impactful opportunity that NASA could take
  - Stakeholder agencies do not have resources to hire experts to download and process satellite data



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AOS Applications Seminar Series

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Monthly seminar to foster dialogue on:

- Opportunities to leverage AOS data products in stakeholder applications and research
- Existing gaps in data needs that may present future opportunities for ESO and AOS
- Engagement of communities to increase awareness of and participation in AOS
- Expand breadth of thematic areas covered in preparation for future activities, including Early Adopter Program

- High seminar attendance (~>70 participants)
- 10 seminars covering a wide range of topics

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How can I get involved with AOS?

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We are here

AOS-I Launch

AOS-P Launch

https://aos.gsfc.nasa.gov/

- Attend AOS events forums
  - AOS Application Seminars
  - Thematic Workshops
- Email applications coordinator andrea.m.portier@nasa.gov to get on our mailing list

National Aeronautics and Space Administration

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Backup

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ACCP Study: Community & Stakeholder Feedback

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ACCP Stakeholder Workshops

- Weather and Air Quality Modeling (7/2019)
- Transportation and Logistics (11/2020)
- Air Quality (3/2021)

Interviews with Communities of Practice and Potential

Surveys and Trainings

- Weather and AQ modeling community
- ARSET GPM training

Science Conference Engagements

AGU, AMS, Community Forums, HAQAST Workshops, GPM Science Team, International Association of Wildland Fire, CALIPSO Science Team

Community Assessment Report

Characterize 10 user communities that could benefit from AOS measurements

- Over 250 workshop attendees and surveys solicited
- Over 60 independent interviews
- Engagement with National/International agencies and the private sector

Non-Traditional User Needs

Summary of new users and applications with a focus on private sector

Inclined Orbit

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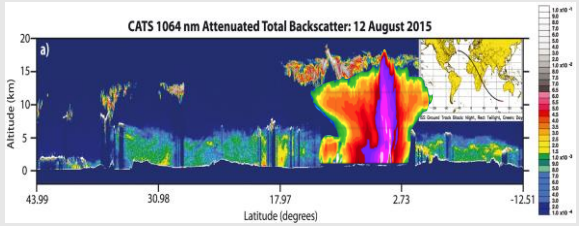
Instrument	AQ Relevant Variables	AQ Applications	How AOS observations can help
Backscatter lidar	• Vertical profiles of aerosol backscatter and extinction • Plume and cloud heights, vertical distribution of plumes • Cloud and aerosol feature masks • Aerosol type (e.g., dust vs. smoke), size, • Other lidar sensors: CALIPSO, CATS 	AQ modeling, monitoring, and forecasting	**Diurnally varying aerosol and cloud heights** improve AQ forecasting, NWP
		Public health	**Aerosol extinction and types** for modeling and PM2.5 estimation
		Wildfire smoke modelling	**Vertical profiles** improves tracking of smoke transport
		Volcanic ash advisories	**Volcanic ash/sulfate discrimination** and **plume height** supports hazard warnings

Polar Orbit

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Instrument	AQ Relevant Variables	AQ Applications	How AOS observations can help
HSRL Lidar	• Vertical profiles of aerosol backscatter and extinction • Plume and cloud heights, vertical distribution of plumes • Cloud and aerosol feature masks • Aerosol type (e.g., dust vs. smoke), size, • Other lidar sensors: CALIPSO, CATS	AQ modeling, monitoring, and forecasting	**Aerosol and cloud heights** improve AQ forecasting, NWP
		Public health	**Aerosol extinction and types** for modeling and PM2.5 estimation
		Wildfire smoke modelling	**Vertical profiles** improves tracking of smoke transport
		Volcanic ash advisories	**Volcanic ash/sulfate discrimination** and **plume height** supports hazard warnings
Polarimeter	• AOD • Plume heights • Aerosol absorbing optical depth (AAOD) • Aerosol fine mode optical depth • Other sensors: MISR, PACE	Air quality monitoring, modeling, and disaster warning	**Plume heights** inform hazardous plume forecasts, and **aerosol type information** improve AQ modeling and forecasting
		Public health	Provides **larger swath and wider context** for the lidar footprint to enable **estimates of extinction and aerosol emissions, aerosol type, and PM2.5 estimates**